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Changes in Avian Community Composition at Sugarcreek Metropark between 1978 and 2010

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Changes in Avian Community Composition

at Sugarcreek Metropark between 1978 and 2010

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By

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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY Jennifer L. Hays ENTITLED Changes in Avian Community Composition at Sugarcreek Metropark between 1978 and 2010 BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF Master of Science.

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ABSTRACT

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Quantifying changes in forest avian diversity is a challenging, but necessary task for development of effective conservation plans. While small changes in diversity accumulate over time, these changes do not necessarily reflect overall long-term trends in species diversity. Long-term changes from established baseline conditions may be more interpretable because the changes in diversity are assessed over longer periods. In 1978, Dr. Reed Noss (1981) initiated a study of thirty-three breeding bird censuses at Sugarcreek Reserve (Metropark) in Southwestern Ohio and evaluated the species richness and composition during the breeding and post-breeding season to inform ecological reserve design theory. In 2010, I replicated Noss' study to examine temporal changes in forest breeding bird communities at Sugarcreek to determine how avifauna diversity, species richness, and community composition have changed since 1978. Rarefaction analysis was used to compare species richness in 1978 and 2010. Individual species were classified as residents (present year-round) and migrants, and these groups were treated in separate analyses. In addition, a spearman rank correlation was used to compare changes in species abundance at Sugarcreek with statewide trends for Ohio. In 1978, Noss (1981) observed 7,609 individuals representing seventy-seven species, but in 2010 using the same protocol and intensity of sampling, I observed 6,445 individuals representing sixty-three species. Rarefaction analysis revealed declines in overall richness, and Shannon-Weiner analysis indicated declines in species diversity. This decline was most pronounced for migratory species. The decline in migrants observed at Sugarcreek mirror declines of migrants elsewhere in Ohio and eastern North America. Sugarcreek might represent a microcosm for the state of Ohio for studying temporal changes in breeding bird diversity and community composition.

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INTRODUCTION

Quantifying changes in forest avian diversity is a challenging, but necessary task for understanding the relationship between environmental variation and effective conservation plans. Environmental conditions, especially those related to forest disturbance and fragmentation, are important to conservation ecologists because they might lead to changes in species richness and abundance of individuals present in communities (Vitousek et al. 1997). Temporal variation within forested habitats can alter community composition of avifauna through environmental stochasticity, which might cause temporary declines or increases in abundance for some species. However, long-term environmental change can cause more permanent changes in species richness and abundance for a particular locality (Parody et al. 2001).

For more effective conservation, researchers should rely on long-term trends to evaluate and predict bird community responses to temporal change. Brooks and Bonter (2010), documented thirty-five years of transition of a breeding bird community at a study site that had undergone secondary forest succession in New York. The numbers of observed territories occupied by forested songbirds suggested that community richness remained relatively stable over time, although eight species declined and twelve species increased in abundance. Observations of permanent residents establishing territories increased over the thirty-five years; however, the numbers of observed territories for some neotropical migrants declined while others increased. However, these local trends were not correlated with regional trends.

Robert Askins (1993) highlighted the effects of forest fragmentation of breeding habitat on migrant populations and suggested that the declines might be a response to several environmental attributes. Widespread destruction of wintering habitat, especially in tropical forests, is considered one of the largest contributors to migrant population declines, as individuals must migrate between degraded habitats with insufficient resources and breeding territory. Alternatively, the destruction, fragmentation, and isolation of forests near suburban and agricultural establishments might also be accountable for declines. However, different forest bird species exhibit different sensitivities to these environmental attributes, and their responses to reduced forest area vary. Breeding bird community composition and turnover might therefore change over time in response to any one or many of these broad attributes. Furthermore, the influences at a local scale might not influence diversity at the regional level. However, with increased localized changes, permanent changes in community structure might be influenced regionally (Parody et al. 2001).

Initiated in 1966, the North American Breeding Bird Survey (BBS 2011) was established to monitor, measure, and evaluate the fluctuation of bird populations on the regional level for the purpose of conservation response (Robbins et al. 1989). The statewide data are especially useful for monitoring sensitive species such as neotropical migrants in small forests, because migrants are more susceptible to local extirpation from stochastic population change (Askins and Philbrick 1987). Population trends for the current state of Ohio suggest that thirteen species are significantly declining including: Cerulean Warbler (*Dendroica cerulea*), Prairie Warbler (*Dendroica discolor*), Least Flycatcher (*Empidonax minimus*), Yellow-Breasted Chat (*Icteria virens*), Purple Martin (*Progne subis*), Eastern Wood Pewee (*Contopus virens*), Great Crested Flycatcher (*Myiarchis crinitus*), and Chimney Swift (*Chaetura pelagica*) (BBS 2011). These regional patterns of decline might also be reflected at more local levels.

Here, I examine changes in avian community composition at Sugarcreek Metropark, Ohio from 1978 to 2010. While the forest during the 1970s was already a degraded system, quantitative baseline data from 1978 are available (Noss 1981). In 1978, Reed Noss (1981) conducted thirty-three avian surveys during the breeding and post-breeding season to assess two objectives: determine species richness and composition of the forest bird community and inform ecological reserve design theory. In this study, I replicated Noss' methods (1981) to quantify changes in diversity and assess the following objectives: (1) identify changes in total abundance, (2) identify changes in species richness and diversity, (3) identify changes in abundance for the most common species, and (4) compare local trends to statewide trends during the same time period.

METHODS

SITE DESCRIPTION AND HISTORY

Sugarcreek Reserve (later Sugarcreek Metropark) located in southwestern Ohio, Greene County (39.617079, -84.097669), is approximately twenty-four kilometers southeast of Dayton and directly southwest of Bellbrook (Fig. 1). Managed by the Dayton Five Rivers Metroparks, Sugarcreek is approximately 237 ha (592 a) and is comprised of remnants of prairie lands, old agricultural cornfields, and woodlots in assorted stages of secondary succession (Noss 1981). Sugar Creek, the major stream for which the park is named, converges with two smaller tributaries to the north and east.

Shortly after European settlement, farmland and agricultural fields primarily bordered Sugarcreek. As a primary means of infrastructure, farm lanes and roads were constructed for travel between the surrounding fields and movement of cattle between pastures. These lanes and roads remain in Sugarcreek as remnants of the old agricultural "footprint" and are utilized as contemporary trail use (D. Nolin, personal communication). During this time, the forest in Sugarcreek consisted of American Beech (*Fagus grandifolia*) with assorted Oak (*Quercus* spp.), and Elm (*Ulmus* spp.) – Ash (*Fraxinus* spp.) forest occurred along creeks and floodplains (Noss 1981). Since the time of settlement, remnants of numerous smaller to moderately sized areas of mature Beech–Maple (*Acer* spp.) forest and mixes of other tree species adapted to moderately moist environments have remained (Noss 1981).

Prior to the 1960s, Sugarcreek was mature Beech–Maple forest, consisting of several other dominant species including: Elm, Basswood (*Tilia americana*), Sugar Maple (*Acer saccharum*), and Hophornbeam (*Ostrya virginiana*) (D. Nolin, personal communication). Later in the 1960s, the forest was converted to row crop agriculture. In effort to reconvert and replace the agricultural field, the park manager in the late 1970s started hand collecting the local seeds from local prairie remnants in attempt to establish a surrogate prairie, as it was once an important regional habitat component prior to European settlement (D. Nolin, personal communication). After Noss (1981) completed his surveys in 1978, the fallow row crop area contained an abundance of Box Elder (*Acer negundo*) and Black Cherry (*Prunus serotina*). This was cut and burned (Noss 1981) and converted to a surrogate tallgrass prairie.

When Noss (1981) conducted his surveys in 1978, the bottomlands bordering along the creek consisted of mixed stands including: Sycamore (*Platanus occidentalis*), Cottonwood (*Populus deltoides*), Hackberry (*Celtis occidentalis*), Chinquapin Oak (*Quercus muehlenbergii*), Box Elder, Slippery Elm (*Ulmus rubra*), and Ohio Buckeye (*Aesculus glabra*) (Noss 1981). These bottomlands were disturbed in 1972 by the installation of **a** sewer line, which maintained a right-of-way that later became a wet meadow (Noss 1981). While the majority of Sugarcreek during the late 1970s was categorized as mixed forests, little of it was mature. Rather, the forests consisted of many areas of different ages, the youngest less than ten years into secondary succession (Noss 1981).

Today, Sugarcreek is 94% natural habitat, consisting of forest (492.16 a), controlled succession (12.94 a), prairie (23.85 a), meadow (9.69), conifer (9.35 a), oak savanna (0.64 a), pond (0.8 a), and creek (9.39 a) (Fig. 1). The remaining 6% is support facilities utilized by the management and visitors. Approximately 83% is forest, consisting of several forest types including: (1) successional hardwoods dominantly consisting of White Ash (*Fraxinus americana*), Black Cherry, Black Locust (*Robinia pseudoacacia*), and Hackberry, (2) Oak-Hickory (*Carya* spp.) forest, (3) mixed mesophytic forest consisting of a diverse mix of Oaks, Hickory, Beech, Sugar Maple, Ash, Yellow Poplar (*Liriodendron tulipifera*), and

Basswood, (4) Sycamore-Cottonwood-Box Elder with Silver Maple (*Acer saccharinum*) and Willow (*Salix* spp.) as common associates, (5) mixed bottomland hardwoods usually Black Walnut (*Juglans nigra*), Hackberry, Yellow Poplar, Bitternut Hickory (*Carya cordiformis*), Ohio Buckeye, Elm, and Bur Oak (*Quercus macrocarpa*), and (6) Pine (*Pinus* spp.) – Spruce (*Picea* spp.). Since the survey by Noss (1981), forests have undergone succession. The youngest is at present forty years old. In the late 1970s, invasive Amur Honeysuckle (*Lonicera maackii*) colonized and quickly spread throughout Sugarcreek. Today, the majority of all forest areas have more than 40% coverage by Amur honeysuckle, and some have coverage as high as 70% (D. Nolin, personal communication).

By 1995, the Dayton-Montgomery County Park District renamed “Sugarcreek Reserve” as “Sugarcreek Metropark.” Over the decades, increasing human populations around suburban Centerville and Bellbrook has lead to residential encroachment around Sugarcreek’s perimeter. Among the most popular recreational uses of Sugarcreek are wildlife viewing, hiking, jogging, and dog walking.

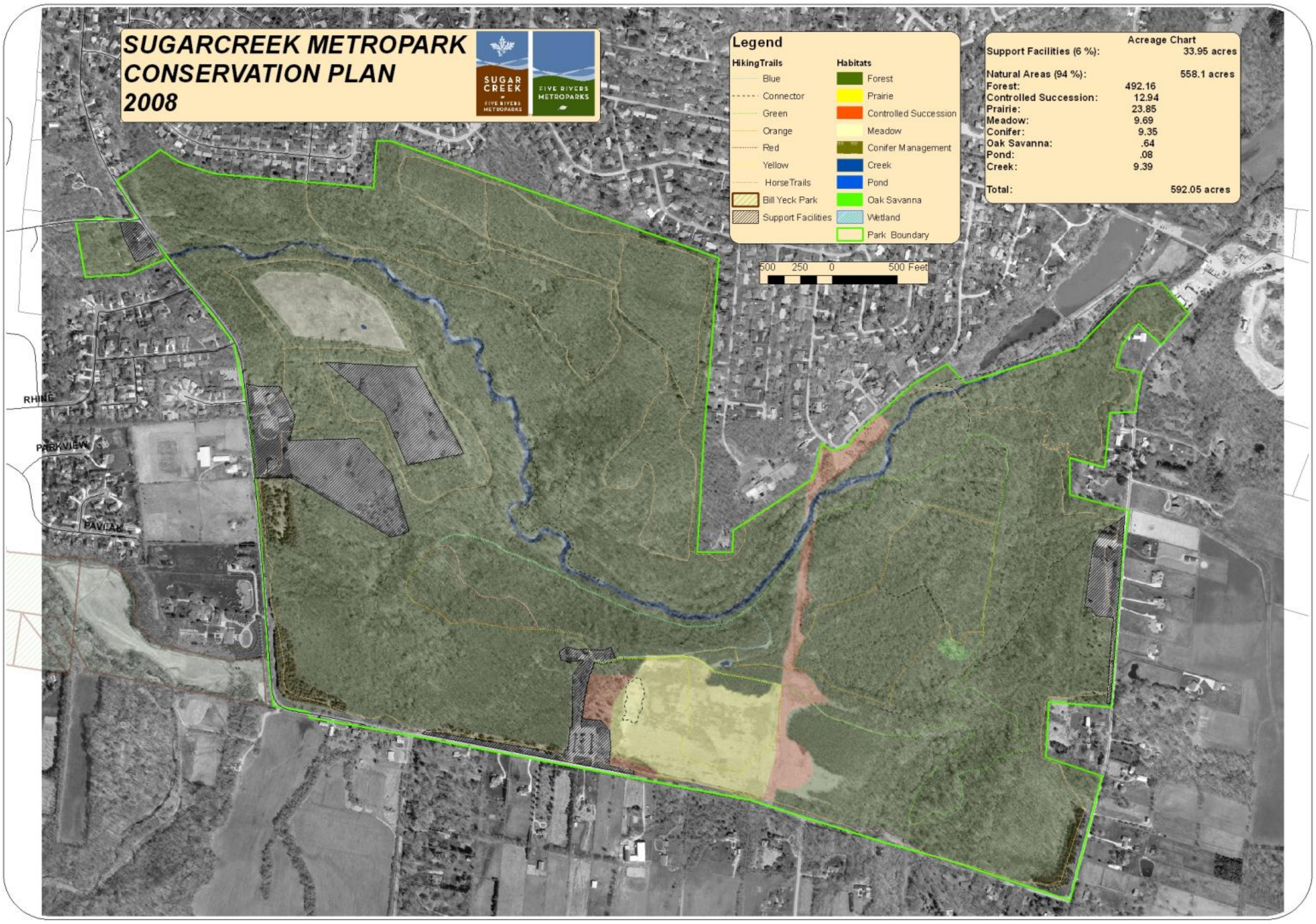


Fig. 1 – Sugarcreek in Greene County, southwest of Bellbrook, Ohio. Note the encroachment from the northern suburbs of Bellbrook (D. Nolin, personal communication). Photograph shows the most recent conservation plan (2008) and demographics of Sugarcreek.

FIELD METHODS

In 1978, Noss (1981) initiated a study of the birds of Sugarcreek Reserve (Metropark) to determine species richness and composition during the breeding and postbreeding season (Noss 1981). Because a reserve is only a sample of some larger, natural community, Noss (1981) aimed to interpret his findings to inform ecological reserve design theory.

From 31 May to 9 August, Noss (1981) conducted thirty-three breeding bird census**es,** which is the time period during which bird patterns are the most stable, and nearly all are in established territories (Noss 1981). Censuses took place weekly (defined as Sunday – Saturday), beginning a half hour before sunrise and continuing for three hours. Surveys were only conducted during mornings of fair weather conditions and in the absence of both precipitation and high wind speeds.

Using both an auditory and visual fixed-strip technique (width a constant forty meters), Noss (1981) walked slowly, approximately 1.5 km/hr, with frequent pauses to look and listen for birds. All birds seen, heard, or both were recorded within twenty meters in both lateral directions of the walking path (Noss 1981). Birds flying overhead and in all directions along the strip were also accounted (Noss 1981). Different parts of Sugarcreek were walked on different days in a randomly selected approach to equally cover all parts of the area over a week's time (Noss 1981). Trails were followed and maintained as much as possible; however, some deviation away from these trails was necessary to survey back areas and other types of substantial habitat (Noss 1981).

I repeated this study in 2010, sampling Sugarcreek using Noss' 1978 methods and confirmed my protocols with Dr. Noss (personal communication) taking special care to replicate the scale in the field. Using Noss' 1978 map as a guide, bird survey routes were established to create a "Noss mimic" from the current map. Sugarcreek was then separated into three large survey areas that covered only the trails present in 1978. I surveyed only the areas that Noss (1981) covered. Trails were used as the primary routes for surveys. Each trail route was divided and designated as one complete route per day, creating three total routes. Using Noss' 1978 listed species, a field data record sheet was also created as a bird survey "tally-checklist."

Each week, we surveyed routes from the "Noss mimic" map by arbitrarily choosing the order in which they were surveyed. The start time, date, weather conditions, temperature (^{o}F), and wind speed (mph) were recorded. All birds seen, heard, or both, in flight overhead, and in all directions along the trails were identified, counted, and recorded on the field data record sheet. After a survey was completed, the finishing time, temperature (^{o}F), and wind speed (mph), was recorded.

DATA ANALYSIS

To identify changes in both richness and abundance of the total communities, species for both the 1978 and 2010 data sets were ranked in order from most to least relative abundant. Rank abundance curves were then generated and plotted as the relative abundance against the total number of species for each community (Magurran 1995). Because total communities contained unequal numbers of individuals, rarefaction curves were generated using Analytic Rarefaction 2.0 (Hunt Mountain Software 2009). For the purpose of species richness comparisons, total community rarefactions were generated for individual-based data and included the 95% confidence intervals (Gotelli and Colwell 2001). To describe community diversity and evenness in 1978 and 2010, I also computed a Shannon-Weiner Diversity Index (H') and a Berger-Parker Dominance Index (d) for each time period.

Species for the 1978 and 2010 total community data sets were separated and categorized as residents and migrants from Ohio, Green County, and from May – August according to *eBird* (2010). Species within each resident and migrant category for both the 1978 and 2010 data were again ranked in order from most to least relative abundant. Rank abundance curves were generated and plotted as the relative abundance against the total number of species for each resident and migrant category (Magurran 1995).

Because each of these categories also contained unequal numbers of individuals, the 2010 data set for both the residents and migrants were rarified to match the 1978 data. To compare the resident and migrant samples, individual-based rarefaction curves were generated using Analytic Rarefaction 2.0 (Hunt Mountain Software 2009). This allows for a meaningful standardization of the data sets based on the number of individuals in each of the resident and migrant communities (Gotelli and Colwell 2001).

To determine if there were any changes in the abundance of the most common birds between sampling periods, I compiled a list of the ten most abundant species in 1978 and 2010. Because only three species were common to both lists, we analyzed data for seventeen species. For each species, I tested the null hypothesis that the number of individuals present did not change between sampling periods. I tested this hypothesis using a two by two contingency table evaluated using a chi-square test. I averaged the number of individual birds per time period and used this as our "expected" value. I applied a Bonferroni correction to our P-values, so statistical significance was applied for species for which $P < 0.0029$.

To determine how the local richness of the Sugarcreek bird communities in 1978 and 2010 compare to the statewide data for Ohio (BBS 2011), annual growth and decline rates were calculated for all species. This is calculated as:

$$Sp_{(x)} = (\ln (I_{x2010}) / (I_{x1978})) / 32)$$

where $Sp_{(x)}$ is the annualized change in species abundance and I_x is the number of individuals for that species of interest. These annualized percent changes were compared to the 1978 and 2010 statewide data for Ohio (BBS 2011) and for Sugarcreek for thirty-one species with ten or more individuals observed for each year. To determine if there was a significant relationship between local and statewide trends in growth or decline rates, I used a Spearman Rank Correlation.

RESULTS

Species Richness

The 1978 census contained 7,609 observations representing 77 bird species. In my 2010 census I counted 6,443 individuals representing 63 species. When all data from the 1978 sample were rarefied to 6,443 individuals, I obtained 76.5 species present in 1978 (95% confidence interval = 75.1 to 77.8 species), representing a 19.0% decline in species richness for the total community between 1978 and 2010 (Fig. 2).

I further examined trends in resident species and migratory species. Noss' 1978 census contained 4,881individuals representing 37 resident species, whereas I recorded 5,125 individuals representing 34 species in 2010. When data from the 2010 sample were rarefied to 4,881 individuals, I obtained 33.9 species (95% confidence interval = 33.5 to 34.4), representing an 8.2% decline in resident species richness between 1978 and 2010 (Fig. 3). With respect to migrants, Noss' 1978 census contained 2,727 individuals representing 40 migratory species, whereas I observed only 1,317 individuals representing 28 species. When data from the 1978 sample were rarefied to 1,317 individuals, I obtained 38.7 migratory species (95% confidence interval = 36.8 to 40.7 species), representing a 27.7% decline in migratory species richness between 1978 and 2010. (Fig. 4).

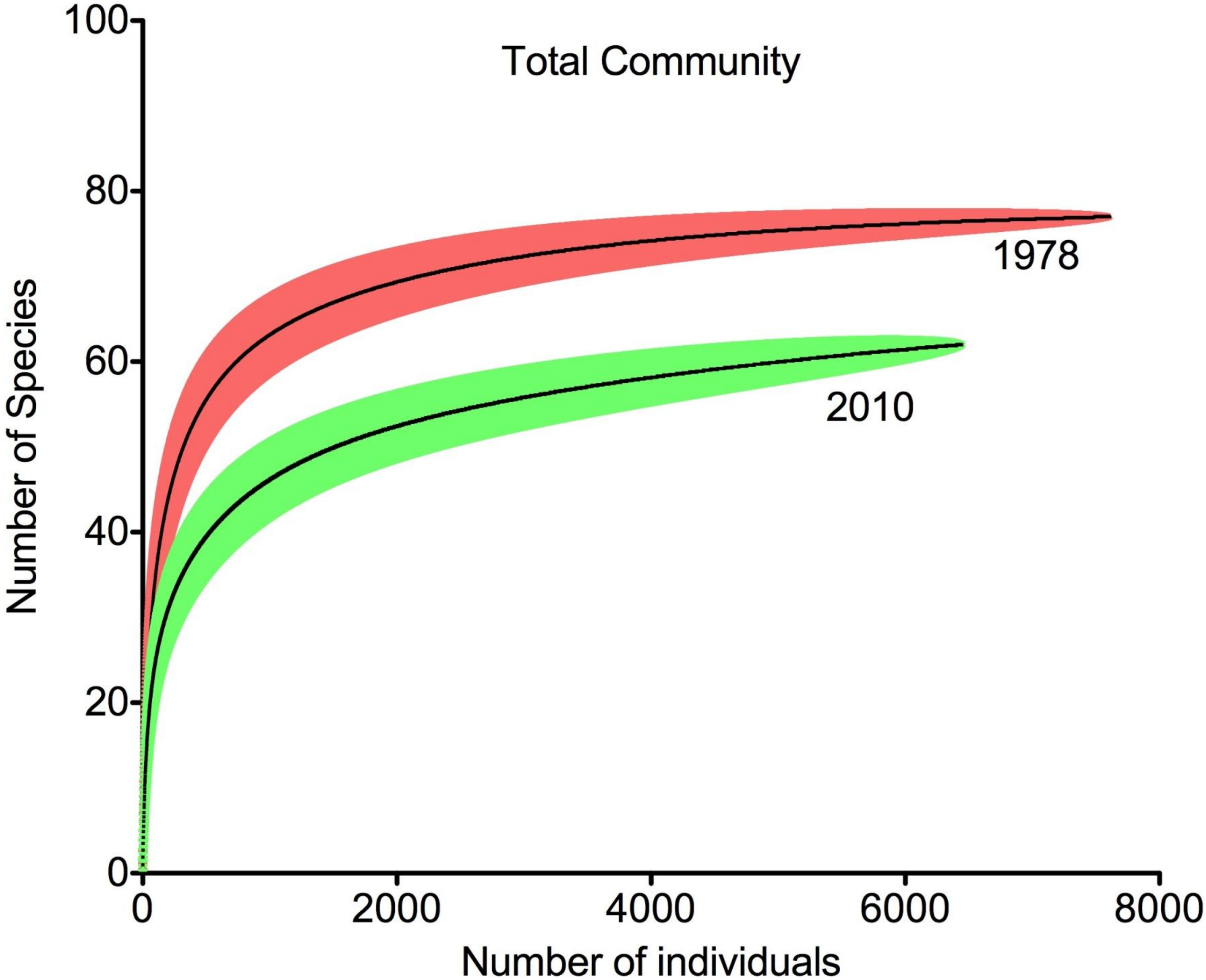


Fig. 2 – Rarefaction curves of the total community for the breeding birds of Sugarcreek 1978 and 2010. Rarefaction of 1978 data indicates that 76.3 species would be expected in a sample size equal to the 2010 data (95% confidence interval = 75.1 to 48.8 species).

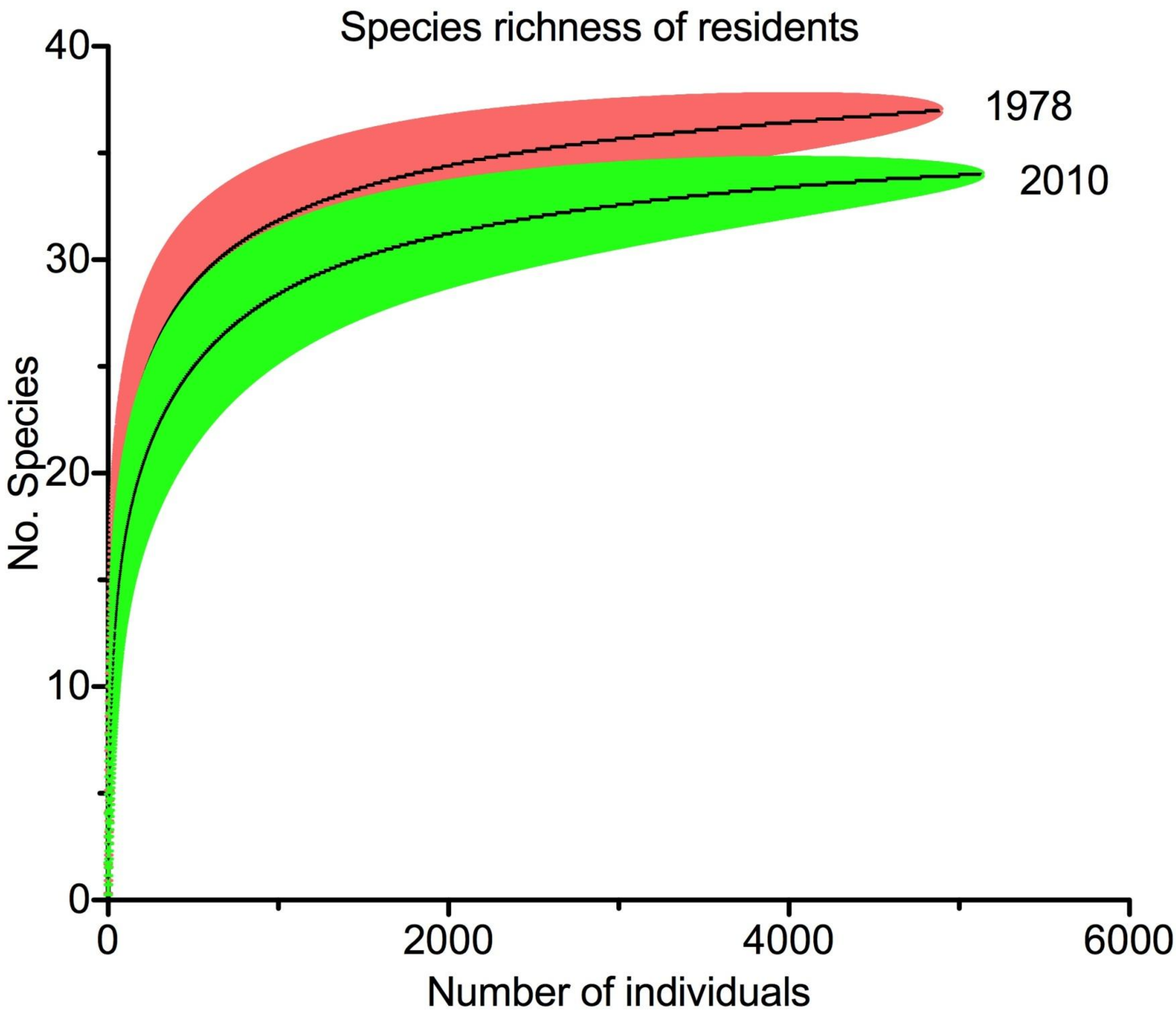


Fig. 3 - Rarefaction curves for the resident community of the birds of Sugarcreek 1978-2010. Rarefaction of the 2010 data indicates that 33.9 species would be expected in a sample size equal to the 1978 data (95% confidence interval = 35.5 to 34.4 species).

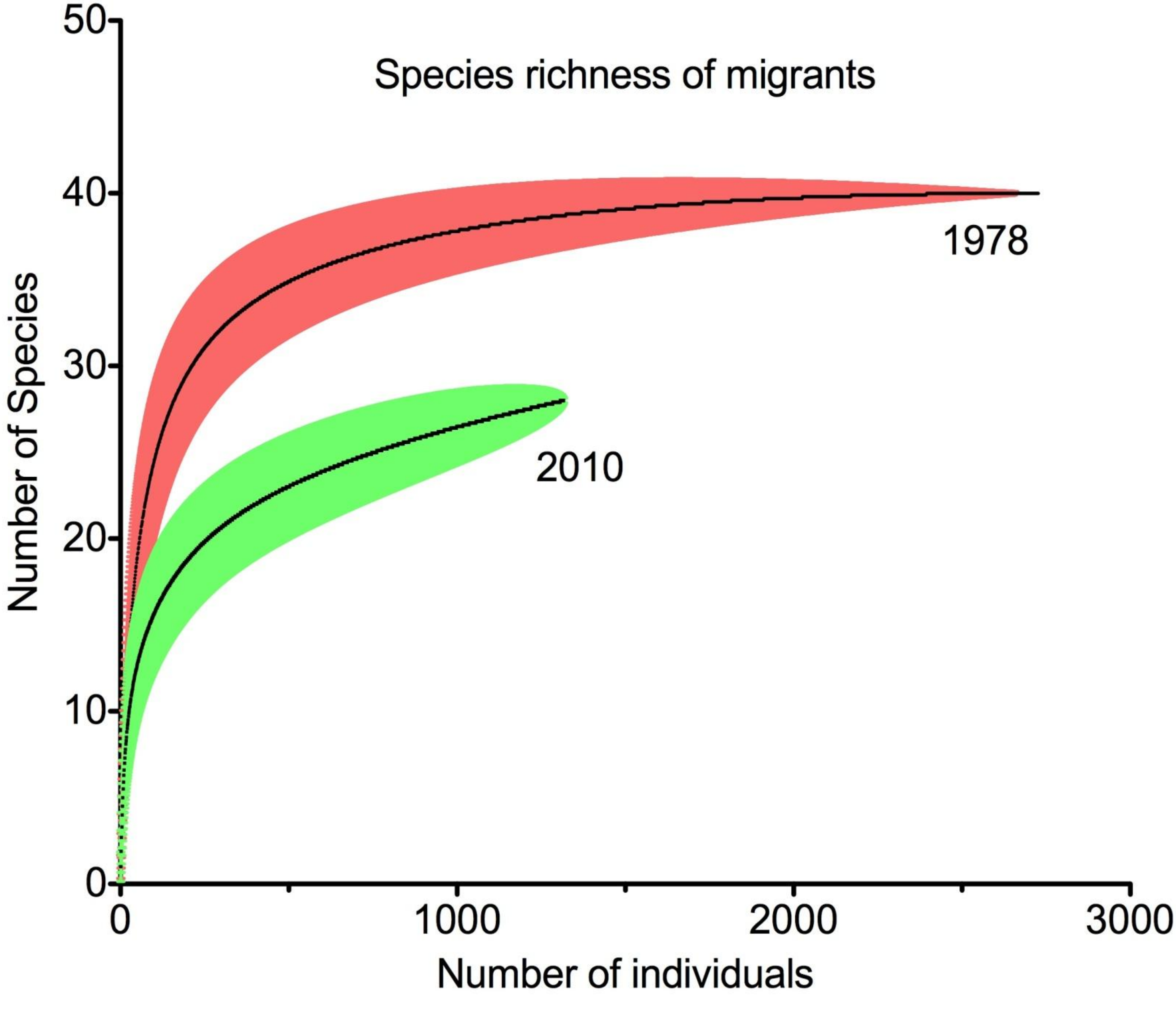


Fig. 4 - Rarefaction curves for the migrant community of the birds of Sugarcreek 1978-2010. Rarefaction of 1978 data indicates that 38.8 species would be expected in a sample size equal to the 2010 data (95% confidence interval = 33.5 to 34.4 species).

Relative Abundances and Species Identity

Among all birds, patterns of rank abundance for the total community between 1978 and 2010 suggest decreased species richness and increased dominance as indicated by differences in the ranks and the relative abundance of the most common species (Fig. 5). When the total community was subcategorized into residents (Fig. 6) and migrants (Fig. 7), similar patterns of ranks suggest decreased species richness and increased dominance. The most pronounced differences between years were observed for migratory species.

Among all species, Common Grackles (*Quiscalus quiscula*) were the most common in 1978 with 533 observations (relative abundance = 7%) for the total community. Conversely, in 2010 Northern Cardinals (*Cardinalis cardinalis*) were the most common species with 1,613 observations (relative abundance approximately 25%) (Fig. 5). Common Grackles were also the most common resident species in 1978 (relative abundance approximately 11%), and Northern Cardinals were the most common resident species in 2010 (relative abundance approximately 32%) (Fig.6). In 1978, Blue-Gray Gnatcatchers (*Polioptila caerulea*) were the most common migrant species with 385 observations (relative abundance approximately 14%), and Acadian Flycatchers (*Empidonax virescens*) were the most common migrant species in 2010 with 294 observations (approximately 22%) (Fig. 7).

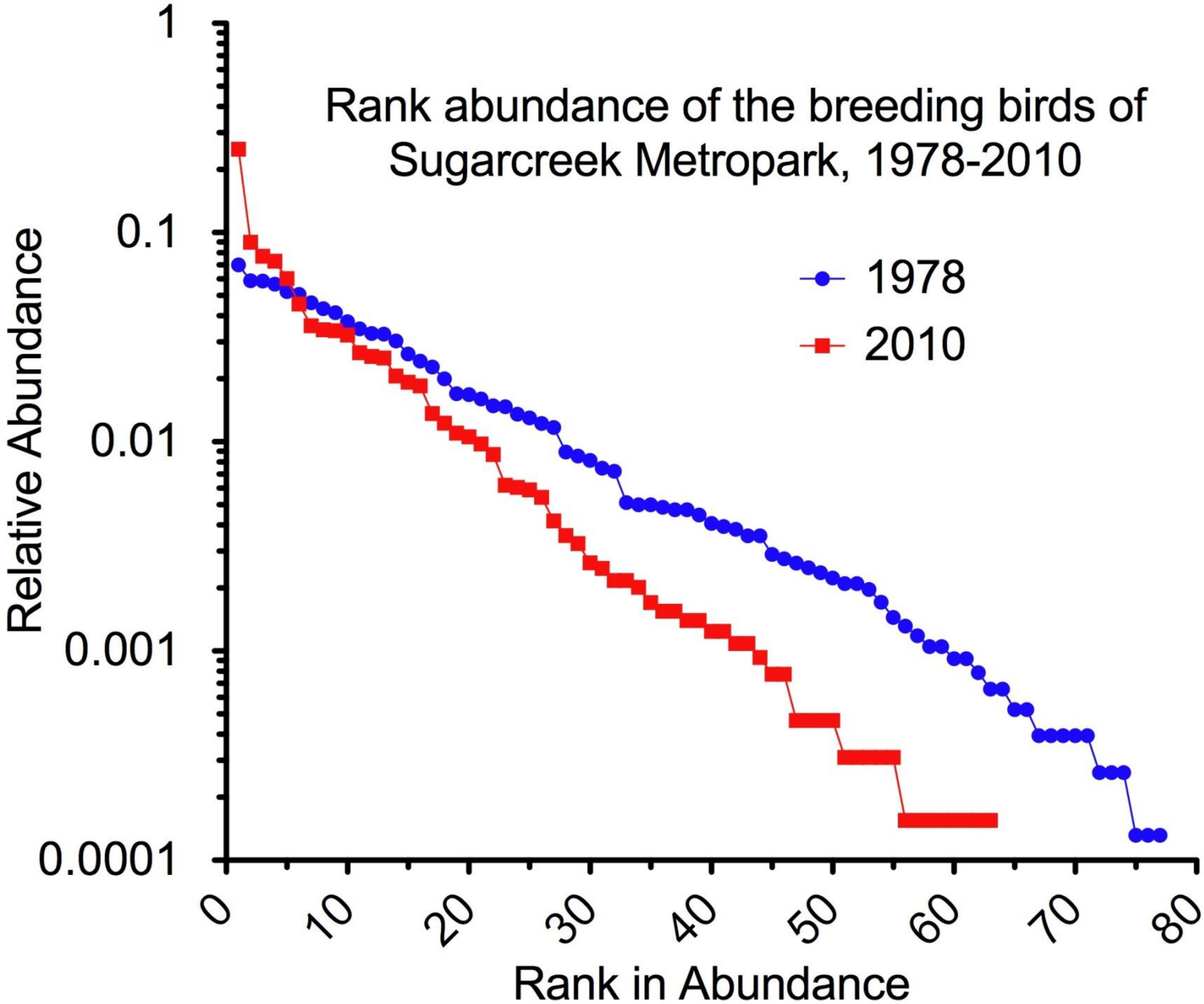


Fig. 5 – Rank abundance curves for the community of the breeding birds of Sugarcreek between 1978 and 2010. Shannon-Weiner H' = 3.59 in 1978 and 2.92 in 2010. Berger Parker d = 0.07 in 1978 and 0.25 in 2010.

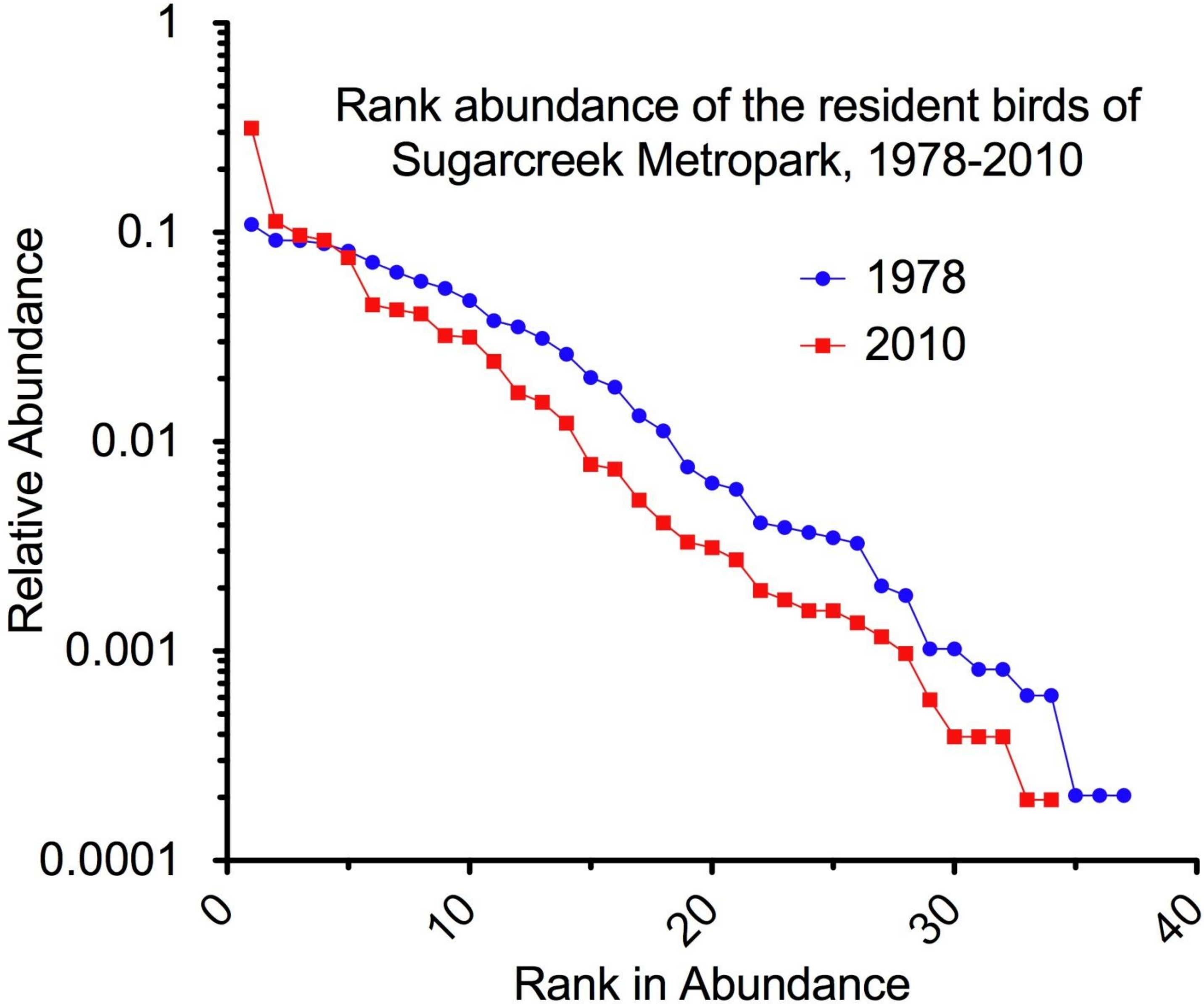


Fig. 6- Rank abundance curves for the residents of Sugarcreek for 1978 and 2010.

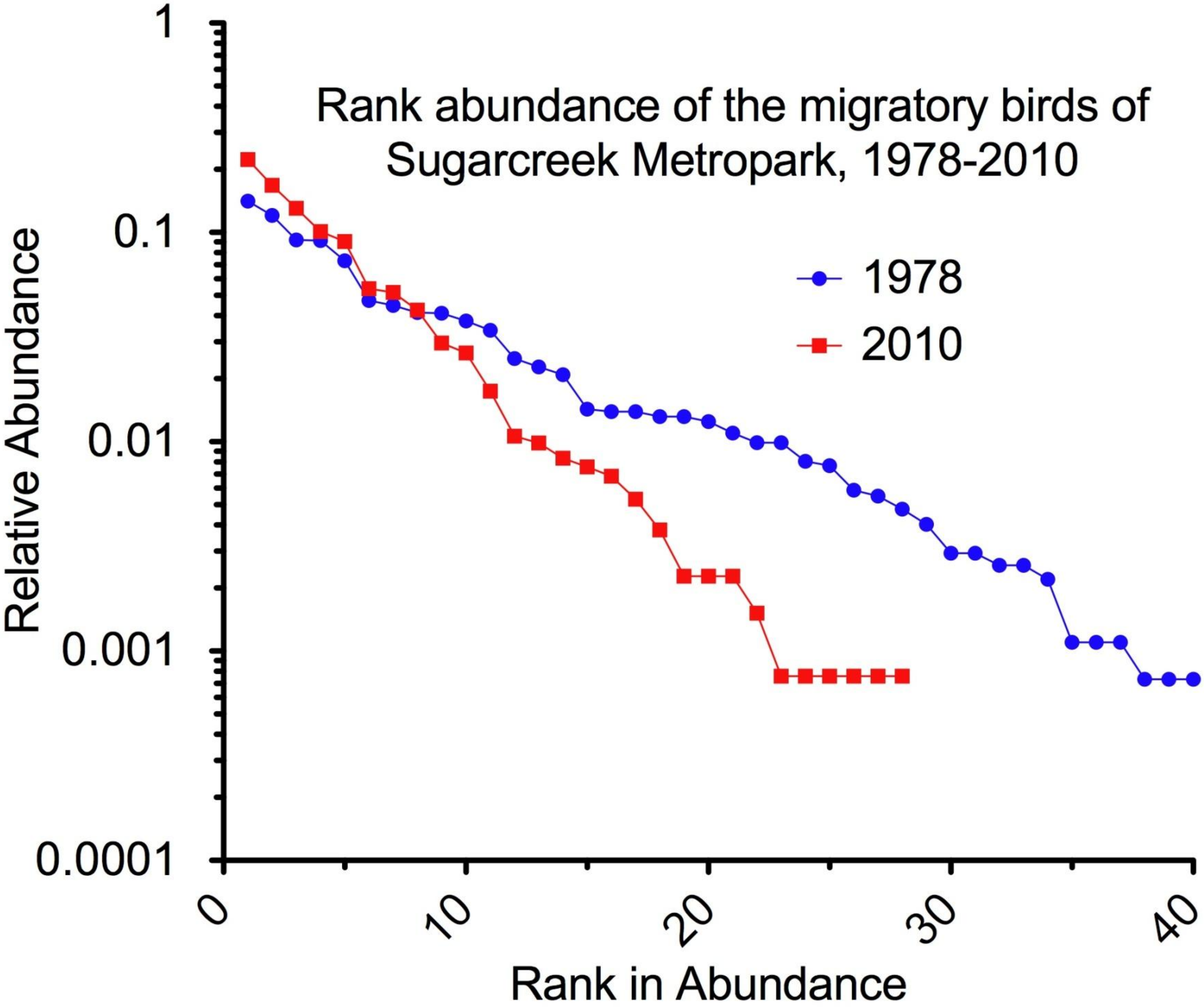
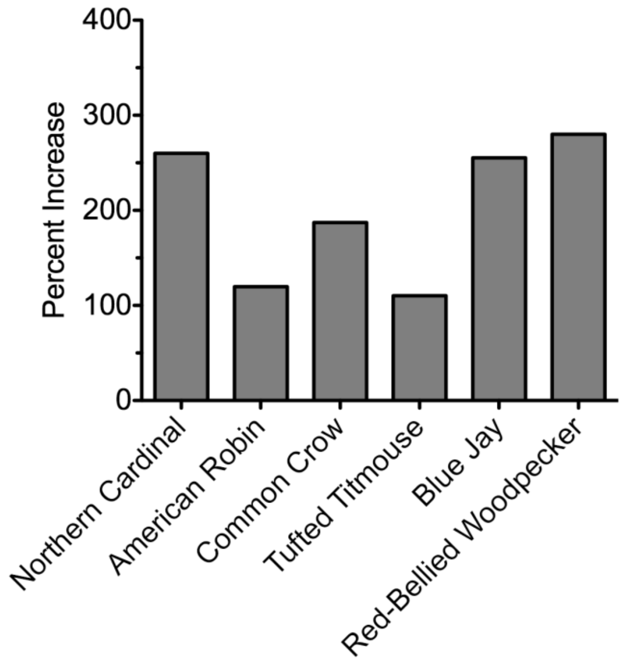


Fig. 7 – Rank abundance curves for the migrants of Sugarcreek between 1978 and 2010.

Of the ten most abundant species in at least one sampling season, six have increased at least twofold since 1978: Northern Cardinals, Common Crows (*Corvus brachyrhynchos*), Blue Jays (*Cyanocitta cristata*), and Red-Bellied Woodpeckers (*Melanerpes carolinus*) (Fig. 8A). Seven of eight species have declined by more than 50% since 1978: Common Grackles, Red-Winged Blackbirds (*Agelaius phoeniceus*), American Goldfinches (*Carduelis tristis*), Blue-Gray Gnatcatchers, European Starlings (*Sturnus vulgaris*), Field Sparrows (*Spizella pusilla*), and Brown-Headed Cowbirds (*Molothrus ater*). Five of eight species have declined by more than 90% (Fig. 8B): Common Grackles, Red-Winged Blackbirds, American Goldfinches, European Starlings, and Brown-Headed Cowbirds. Changes were considered statistically significant at $P < 0.0029$ ($P < 0.05$ with a Bonferroni correction). Three species showed no statistically significant changes in abundance: Carolina Chickadees (*Poecile carolinensis*), Acadian Flycatchers, and Eastern Towhees (*Pipilo erythrophthalmus*).

(A)



(B)

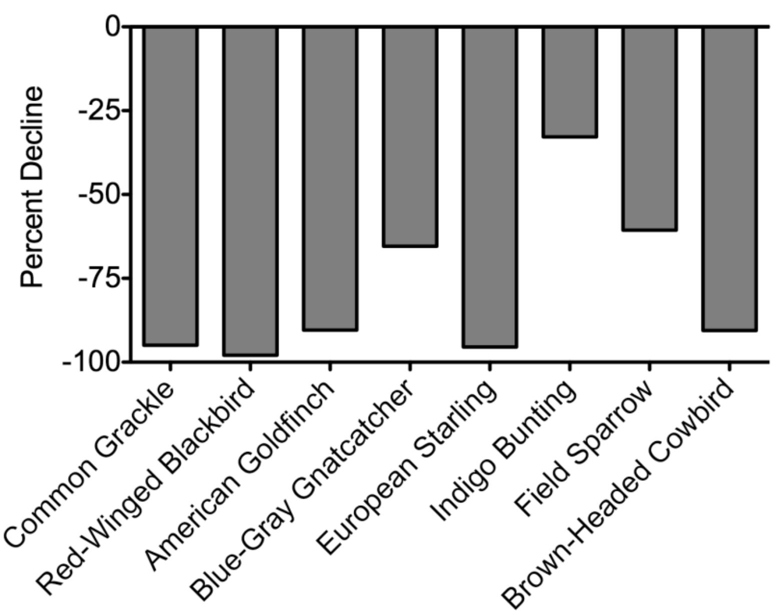


Fig. 8 – Percent increase (A) or decrease (B) of the ten most abundant species between 1978 and 2010. Changes are statistically significant at $P < 0.0029$ ($P < 0.05$ with a Bonferroni correction).). Changes for Carolina Chickadees, Acadian Flycatchers, and Eastern Towhees were not significant (not shown).

Trends at Sugarcreek Reflect Statewide Changes

Temporal change in species abundance at Sugarcreek reflect changes in Ohio during the same period. Although the magnitude of change of particular species at Sugarcreek are greater than for the state as a whole, the local and regional data are positively correlated for the 31 species with ten or more individuals recorded in each time period (Spearman $r = 0.40$; $P = 0.026$; Fig. 9). For most species, Sugarcreek appears to be a microcosm for the state. However, there are exceptions. Some species declined at Sugarcreek but increased statewide: Yellow-Throated Warbler (*Dendroica dominica*), Red-Eyed Vireo (*Vireo olivaceus*), Mourning Dove (*Zenaida macroura*), Indigo Bunting (*Passerina cyanea*), House Wren (*Troglodytes aedon*), and Common Grackle. Likewise, some species increased at Sugarcreek but exhibited statewide declines: Acadian Flycatcher, Eastern Wood Pewee, and Tufted Titmouse (*Baeolophus bicolor*).

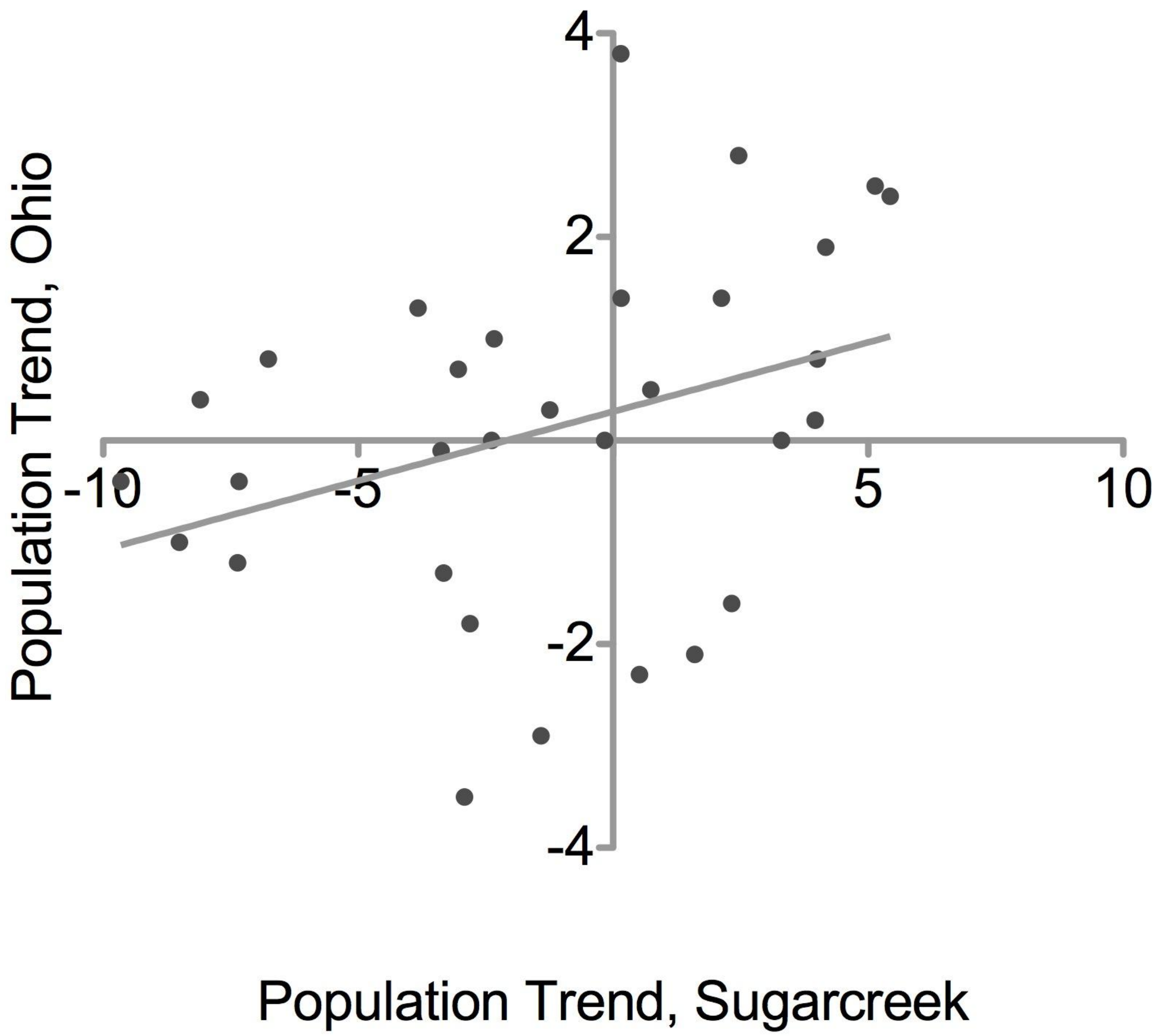


Fig. 9 – Spearman rank correlation for temporal change in species abundance at Sugarcreek and Ohio during the same time period. There is a positive correlation for the thirty-one species with ten or more individuals recorded in each time period (Spearman r = 0.40; P = 0.026).

DISCUSSION

I found significant changes in the avian community in Sugarcreek between Noss' 1978 baseline data (Noss 1981) and our 2010 survey. Specifically, my observations are consistent with temporal change at Sugarcreek, including (1) declines in the number of bird observations, (2) declines in richness, especially for the migrants, (3) increases in dominance, (4) changes in the identity of the most common species, and (5) changes in species abundance. These patterns at Sugarcreek generally reflected changes in Ohio during the same period with a few exceptions.

The total numbers of birds for the community suggested a decline of 19% between 1978 and 2010. When separated into residents and migrants, the number of residents declined by 8.2%, whereas the number of migrants declined by 27.7%. Other studies also reported declines in abundance, especially for migrants in New Hampshire (Holmes and Sherry 1986; Holmes and Sherry 2001) and Connecticut (Askins and Philbrick 1987). Several factors might account for fewer bird observations in our study including: (1) declines in the number of individual birds, (2) environmental stochasticity (i.e., year to year variation in the number of birds), and (3) differences in observers (Preston 1979). Holmes and Sherry (2001) suggested evidence for declines in the numbers of birds at Hubbard Brook in New Hampshire. I argue that my data also reflect actual declines in bird abundance, but these declines were not as pronounced at Sugarcreek. Furthermore, my data are consistent with long-term regional trends, suggesting that this site is a microcosm that reflects real changes in abundance and diversity. However, environmental stochasticity and differences in observers cannot be conclusively discounted without additional years of surveys and methods to measure observer bias.

Migrants most strongly revealed temporal change at Sugarcreek, because they experienced the greatest magnitude of differences in abundance and richness between 1978 and 2010. Several studies also reported decreased species richness, especially for migrants in wooded habitats bordered by agricultural farming and urban areas in eastern deciduous forests and southern Wisconsin (Brooks and Bonter 2010; Ambuel and Temple 1982; Whitcomb et al. 1981). A negative impact on the migratory forest bird richness in Sugarcreek might therefore be a response to the local increase of suburb-adapted species establishing permanent residence and dominating total community composition as urban development encroaches its perimeter.

Holmes and Sherry (2001) conducted a thirty year study of breeding bird communities in a relatively undisturbed forest in New Hampshire. The study suggested declines in bird abundances which were most pronounced in the migrants. Patterns of negative trends in the migrant community corresponded with general declines in the abundance of migrants for the region (Robbins et al. 1989; Fig. 9). Other studies have noted these patterns and documented declining migrant populations (Rittenhouse et al. 2010; Friesen et al. 1995). Thus, my observed declines might be more reflective of regional trends rather than trends specific to Sugarcreek.

Askins and Philbrick (1987) detected a negative relationship between suburban species (defined as species that are common to forested residential areas and edge habitats) and migrants during a thirty-two year study at an isolated twenty-three hectre woodlot in Connecticut. The study found that the abundance of suburban species was a significant predictor of abundance of migrants; however, no correlation was found with regional forest area. Results suggest that suburban species density increased as the migrants declined. Our study reflected this pattern by suggesting increases in the following resident species: Northern Cardinal, American Robin (*Turdus migratorious*), Carolina Chickadee, and Tufted Titmouse. In parallel to the Carolina Chickadee, Askins and Philbrick (1987) highlight increased abundances of the Black-Capped Chickadee (*Poecile Atricapilla*) and similarity of increased abundances of Tufted Titmice. Our results are also consistent with findings in southern Wisconsin and eastern North America that suggest long-term declines in forest migrant communities (Ambuel and Temple 1982; Weise et al. 2004; Holmes and Sherry 1986; Holmes and Sherry 2001). Collectively, these studies demonstrate broad patterns of migratory bird declines.

In contrast to migrants, the total number of resident individuals observed did not change significantly between sampling periods at Sugarcreek. Common resident species including Northern Cardinals, Common Crows, Blue Jays, and Red-Bellied Woodpeckers have all increased nearly two-fold since 1978 perhaps as a response to intense urban development, recreation, and disturbance. Conversely, Red-Winged Blackbirds, Common Grackles, and Brown-Headed Cowbirds have declined by more than 75%. We speculate the decline in the abundance of the Brown-Headed Cowbirds stems from the absence of livestock in remnants of old farmland surrounding Sugarcreek. However, factors contributing to the declines in Red-Wing Blackbirds and Common Grackles remain unclear.

Our study also found increases in some species tolerant of increased recreation and disturbance, such as hiking, jogging, dog-walking, and horseback riding. Horn (1985) surveyed the population densities of breeding birds in an eleven hectre woodlot near Columbus, Ohio and described the response of avifauna to forest succession and urbanization during 1938- 42 and 1979 – 84. His study suggested that urbanization has lead to increased diversity and abundance of plantings including berry-bushes and evergreens that have enhanced numbers of resident species, including Blue Jays, American Robins, and Northern Cardinals. While Horn (1985) highlights other species that increased as a response to increased diversity of shrubs and urbanization, our study did not find similar trends for some species, including Red-Winged Blackbirds, Common Grackles, Mourning Doves, and House Sparrows (*Passer domesticus*).

Similar to the study conducted by Horn (1985), increased urban development and encroachment around Sugarcreek might have contributed to increased densities of the invasive Amur Honeysuckle. In 1979, shortly after Noss (1981) completed his surveys, the exotic shrub increased in abundance across the Sugarcreek area. As a response, the abundance of resident avifauna may have increased, as the invasive shrub possibly became a suitable food source for frugivores. Some of these permanent residents are also probable habitual feeder-visitors, whose abundance might have increased in our study because of increased over-winter survival resulting from the increased popularity of suburban dwellers to maintain feeders (Horn 1985).

I found similar patterns of change in the avifauna of Sugarcreek and broad-scale patterns in Ohio during the same period. Although the magnitude of change for a particular species at Sugarcreek was greater than for the statewide trends in Ohio, the local and regional data are positively correlated. For the majority of our species, Sugarcreek resembles a microcosm for the state; however, there are a few exceptions. Of the thirty-one species, twenty-two maintained stable numbers or increased in abundance at Sugarcreek and throughout Ohio between 1978 and 2010 and consisted of both residents and migrants. Conflicting trends between Sugarcreek and the regional BBS level for Ohio were found for nine species. Out of the nine species, six species declined locally at Sugarcreek with stable or increasing trends statewide: Yellow-Throated Warbler, Red-Eyed Vireo, Mourning Dove, Indigo Bunting, House Wren, and Common Grackle. Three species were stable or increasing at Sugarcreek, but declined statewide: Acadian Flycatcher, Eastern Wood Pewee, and Tufted Titmouse. Therefore, our findings demonstrate local abundances do not necessarily reflect statewide trends. Holmes and Sherry (2001) found similar patterns in population trends for twenty-four forest bird species at Hubbard Brook and the Breeding Bird Survey (BBS) in New Hampshire. The comparisons at Hubbard Brook and the statewide trend indicated that a majority of the species demonstrated similar patterns locally and regionally. These findings are important for two major reasons. First, researchers that are interested in the population dynamics of multiple species should avoid assuming population stability in the intervening years without census data, and moreover should not assume that any change (increase or decrease) occurred in a linear fashion. Second, the population dynamics of multiple species might change in a similar direction and magnitude for different reasons, or alternatively, might change in different directions and magnitudes in response to the same underlying cause.

In conclusion, data from Sugarcreek demonstrates temporal variation in avian communities over thirty-two years. My focus has been to identify the decline in species richness and indicate local changes in relative abundance at the individual species level. I also have shown a positive correlation between the temporal change in species abundance at Sugarcreek and how it reflects changes in Ohio during the same period. Reasons for change may include factors such as responses to a local increase of permanent residents dominating the total community composition, increased urbanization, recreation, and disturbance, and the natural fluctuation of populations occurring over separate periods of time.

As the forest of varying age in Sugarcreek continues to mature and the area within its boundaries from previous land conversion is restored, avian community composition will change in response to increased recreation and disturbance. Over the next ten years, I predict the avian community composition of Sugarcreek to change in response to (1) stochastic and catastrophic events that might lead to decreased richness and abundance, (2) likelihood of extirpation for a few individual species, and (3) secondary forest succession that might lead to increased abundances of species that are dependent on mature trees.

Environmental stochasticity (i.e., year to year variation in the number of birds) and catastrophic events at Sugarcreek or in stopover and/or wintering grounds, might contribute to the overall decline in species richness and abundance of the avian community. For example, during the 2010 “Deepwater Horizon” British Petroleum (BP) oil spill in the Gulf of Mexico, 4.9 million barrels of crude oil were released from the mobile offshore drilling rig for three consecutive months in 2010 (April 20 – July 15) (Restore the Gulf 2011). A catastrophic event such as this oil spill is especially noteworthy for migrants, because several species must make the journey north from Central and South America every breeding season and cope with the hardship of degraded stopover habitat locations. In addition, this event might have reduced the abundance of some species at Sugarcreek, however there is no certainty for the reduction.

Species most likely to become extirpated are: Cerulean Warblers, Kentucky Warblers (*Oporornis formosus*), Blue-Winged Warblers (*Vermivora pinus*), and Scarlet Tanagers (*Piranga olivacea*) as these individual species consisted of the lowest relative abundance of the community and exhibit statewide declines. Among residents, Eastern Bluebirds (*Sialia sialis*) are likely to disappear locally due to local competition with Tree Swallows (*Tachycineta bicolor*) as they frequently nest in man-made bluebird boxes. It is also relevant to predict as the forest in Sugarcreek of varying age continues to mature, some bird species may benefit in response. These species especially include the bark foragers and cavity nesters such as woodpeckers and nuthatches. However, the invasion of the invasive Amur Honeysuckle after 1979, in particular, may be of further research interest in Sugarcreek, as the avian community data given for 2010 may serve as new baseline to evaluate the effects of Honeysuckle on avian community diversity and turnover.

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APPENDIX A

Total Individuals Per Species in Sugarcreek between 1978 and 2010

Species Name	Noss 1978 Total Individuals	Hays 2010 Total Individuals
Acadian Flycatcher (*Empidonax virescens*)	249	294
American Goldfinch (*Spinus tristis*)	397	38
American Kestrel (*Falco sparverius*)	1	0
American Redstart (*Setophaga ruticilla*)	21	0
American Robin (*Turdus migratorious*)	264	580
American Woodcock (*Philohela minor*)	3	0
Barn Swallow (*Hirundo rustica*)	22	1
Barred Owl (*Strix varia*)	3	1
Belted Kingfisher (*Megaceryle alcyon*)	31	6
Black-and-White Warbler (*Mniotilta varia*)	11	0
Black-Billed Cuckoo (Coccyzus erythropthalmus)	27	0
Blue Jay (*Cyanocitta cristata*)	65	231
Blue-Gray Gnatcatcher (*Polioptila caerulea*)	385	133
Blue-Winged Warbler (*Vermivora pinus*)	7	0
Bobwhite (*Colinus virginianus*)	9	0
Brown Thrasher (Toxostoma rufum)	68	1
Brown-Headed Cowbird (*Molothrus ater*)	285	27
Canada Goose (*Branta canadensis*)	0	17
Carolina Chickadee (*Poecile carolinensis*)	447	470
Carolina Wren (*Thryothorus ludovicianus*)	0	79
Cedar Waxwing (*Bombycilla cedrorum*)	16	0
Cerulean Warbler (*Dendroica cerulea*)	122	3
Chimney Swift (*Chaetura pelagica*)	129	0
Chipping Sparrow (*Spizella passerina*)	0	1
Common Crow (*Corvus brachyrhynchos*)	173	497
Common Flicker (*Colaptes auratus*)	99	63
Common Grackle (*Quiscalus quiscala*)	533	40
Common Yellowthroat (*Geothlypis trichas*)	200	68
Cooper’s Hawk (*Accipiter cooperii*)	0	2
Downy Woodpecker (*Picoides pubescens*)	128	162
Eastern Bluebird (*Sialia sialis*)	0	5
Eastern Kingbird (*Tyrannus tyrannus*)	8	35
Eastern Meadowlark (*Sturnella magna*)	5	0
Eastern Towhee (*Pipilo erythrophthalmus*)	231	219
Eastern Wood Pewee (*Contopus virens*)	103	172
European Starling (*Sturnus vulgaris*)	351	16
Field Sparrow (*Spizella pusilla*)	315	124
Gray Catbird (*Dumetella carolinensis*)	38	9
Great Blue Heron (*Ardea herodias*)	1	3

Great Crested Flycatcher (*Myiarchus crinitus*)	27	11
Great Horned Owl (*Bubo virginianus*)	1	1
Green Heron (*Butorides virescens*)	15	0
Hairy Woodpecker (*Picoides villosus*)	4	7
House Sparrow (*Passer domesticus*)	18	8
House Wren (*Troglodytes aedon*)	113	13
Indigo Bunting (*Passerina cyanea*)	329	221
Kentucky Warbler (*Oporornis formosus*)	36	2
Killdeer (*Charadrius vociferous*)	10	0
Mallard (*Anas platyrhynchos*)	20	21
Mourning Dove (*Zenaida macroura*)	37	14
Northern (Balitmore) Oriole (*Icterus galbula*)	6	0
Northern Cardinal (*Cardinalis cardinalis*)	448	1613
Northern Mockingbird (*Mimus polyglottos*)	3	2
Northern Parula (*Parula americana*)	0	23
Northern Rough-Winged Swallow (*Stelgidopteryx serripennis*)	39	0
Ovenbird (*Seiurus aurocapillus*)	8	5
Pileated Woodpecker (*Dryocopus pileatus*)	17	88
Prairie Warbler (*Dendroica discolor*)	0	1
Purple Martin (*Progne subis*)	16	0
Red-Bellied Woodpecker (*Melanerpes carolinus*)	55	209
Red-Eyed Vireo (*Vireo olivaceus*)	251	119
Red-Headed Woodpecker (*Melanerpes erythrocephalus*)	5	0
Red-Shouldered Hawk (*Buteo lineatus*)	0	2
Red-Tailed Hawk (*Buteo jamaicensis*)	4	8
Red-Winged Blackbird (*Agelaius phoeniceus*)	432	9
Ring-Necked Pheasant (*Phasianus colchicus*)	19	0
Rock Dove (*Columba livia*)	89	0
Ruby-Throated Hummingbird (*Archilochus colubris*)	7	3
Scarlet Tanager (*Piranga olivacea*)	2	1
Song Sparrow (*Melospiza melodia*)	152	10
Spotted Sandpiper (*Actitis macularia*)	3	0
Tree Swallow (*Tachycineta bicolor*)	2	39
Tufted Titmouse (*Baeolophus bicolor*)	185	389
Turkey Vulture (*Cathartes aura*)	2	56
Warbling Vireo (*Vireo gilvus*)	13	0
White-Breasted Nuthatch (*Sitta carolinensis*)	29	165
White-Eyed Vireo (*Vireo griseus*)	57	0
Willow Flycatcher (*Empidonax traillii*)	62	0
Wood Duck (*Aix sponsa*)	3	7
Wood Thrush (*Hylocichla mustelina*)	36	71
Yellow Warbler (*Dendroica petechia*)	38	3
Yellow-Billed Cuckoo (*Coccyzus americanus*)	93	0

Yellow-Breasted Chat (*Icteria virens*)	112	0
Yellow-Throated Vireo (*Vireo flavifrons*)	30	14
Yellow-Throated Warbler (*Dendroica dominica*)	34	10

APPENDIX B

Total Individuals Per Survey Day (2010)

Survey	Survey Date	Total Individuals
1	31 May	246
2	2 June	202
3	4 June	147
4	7 June	237
5	8 June	205
6	10 June	151
7	11 June	162
8	14 June	212
9	16 June	188
10	18 June	193
11	20 June	207
12	23 June	183
13	25 June	160
14	29 June	183
15	30 June	161
16	2 July	197
17	6 July	169
18	7 July	228
19	9 July	189
20	14 July	189
21	15 July	197
22	17 July	199
23	19 July	203
24	22 July	205
25	23 July	200
26	26 July	223
27	27 July	226
28	29 July	175
29	2 August	186
30	3 August	242
31	6 August	182
32	7 August	189
33	8 August	208

APPENDIX C

Electronic Database "Paths"

1. North American Breeding Bird Survey (BBS)

    - http://www.pwrc.usgs.gov/BBS/
    - click on "See Results"
    - click on "USGS Results and Analysis"
    - click on "Survey Results"
    - click on "Species Group Summaries"
    - select the time interval (1966-2009)
    - select the state "Ohio"
    - select "Neotropical Migrants"
    - click "Send Data and Conduct Analysis"
    - "Declining Species" → "Significant Trends"

2. eBird

    - ebird.org/content/ebird/
    - click on "View and Explore Data"
    - click on "Bar Charts"
    - select the region "United States"
    - select the state "Ohio"
    - then select a subregion "Counties in Ohio"
    - click "Continue"
    - select "Greene"
    - click "Continue"